MIRI Status
JWST PARTNERS WORKSHOP
May 2009

Gillian Wright/John Thatcher/Dave Wright - European Consortium
George Rieke – University of Arizona
Greg Goodson/Phillip Barela – Jet Propulsion Laboratory
Scott Friedman/Karl Gordon – Space Telescope Science Institute
Melora Larson – Jet Propulsion Laboratory
Astrid Heske – European Space Agency

Introduction/Talk Outline

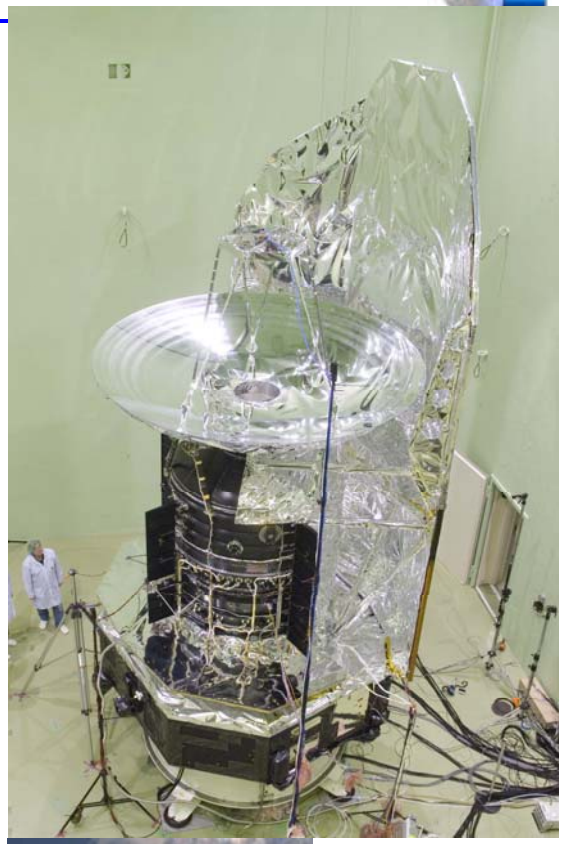
- **This MIRI presentation covers both the MIRI Optical System (ISIM) and the MIRI Cooler System (Observatory)**
- **Highlights**
- **Science Team & Operations**
- **The MIRI STM (ETU) Status**
- **MIRI Optical System FM Status**
  - Focal Plane System
  - Optical Sub-assemblies
  - FM test preparation
  - Thermal Loads and MIRI Shield
- **MIRI Cooler System Status**
- **Risks**
- **Conclusions**

Highlights

- **Held 1st VM Test Results TIM**
- **Developed MIRI thermal shield and passed concept review**
- **Cooler detailed interfaces defined and cooler design progressed for CDR in June**
- **Completed assembly of all the FM wheel mechanism assemblies and started environmental testing.**
- **Completed the three flight focal plane modules, now ready for higher level integration**
- **The LW spare FPM is also completed, SW spare is in environmental test**
- **Assembled flight FPE and now in early functional tests**
- **Completed system EMC test of QM ICE with representative hardware elements**
- **Assembled and started testing of the FM Spectrometer Pre-Optics and FM Imager sub-systems.**
  - Spectrometer Main Optics delivered and stored at RAL
  - IOC assembly has started
- **Science Team and STScI have made great progress in**
  - calibration plans
  - Operations definition, in particular sub-array definition
  - DHAS
- **The MIRI Team supported the ISIM CDR**

Science

- **Herschel will survey the 50-100K universe**
  - one of the last unexplored spectral windows
  - imaging of cool sources, water
  - First two years is allocated to “key programmes”
- **Deep surveys to study**
  - cosmic IR background
  - galaxy evolution & AGN formation
- **Debris Disks survey**
  - Completing SEDs from Spitzer surveys
  - Search for very cool disks
  - Complex Chemistry - gas and dust diagnostics
- **Science goals similar / related to JWST science**
  - Missions are complementary
  - Of course JWST has better resolution, sensitivity
- **Herschel will, in the first place, yield ‘unbiased’ surveys as an input for JWST science**
  - E.g. we can select individual interesting examples to study in detail with MIRI



Science Team Activities

- **Support of spare detector selections**
- **Continued VM test data analysis and preparations for FM testing**
- **Participated in Calibration Summit**
- **Reviewed progress with calibration plans for spectroscopy**
  - Fringing removal techniques
  - Approach to cube building for IFU
- **Prioritised additional DHAS features for use during FM test**
- **Preparing for (internal) science workshop in June**

Operations Progress

- **Issued report on dithering patterns for Imaging and LRS-Slit spectroscopy**
  - Based on Spitzer and Hubble experience
- **Issued report on subarrays for bright sources**
  - Important for planet transients and tie to Hubble/Spitzer bright calibration stars
- **Implementation of the MIRI Templates ongoing**
- **Implemented MIRI readout co-addition**
- **Supported planning for MIRI ISIM testing**
- **MIRI Calibration Plan updated and updates to Operational Concept in progress**
- **Report on preliminary set of absolute calibration stars being written**
  - White dwarfs, A-stars, and solar-type stars
  - Spitzer observations of these stars completed

ETU/ STM Progress

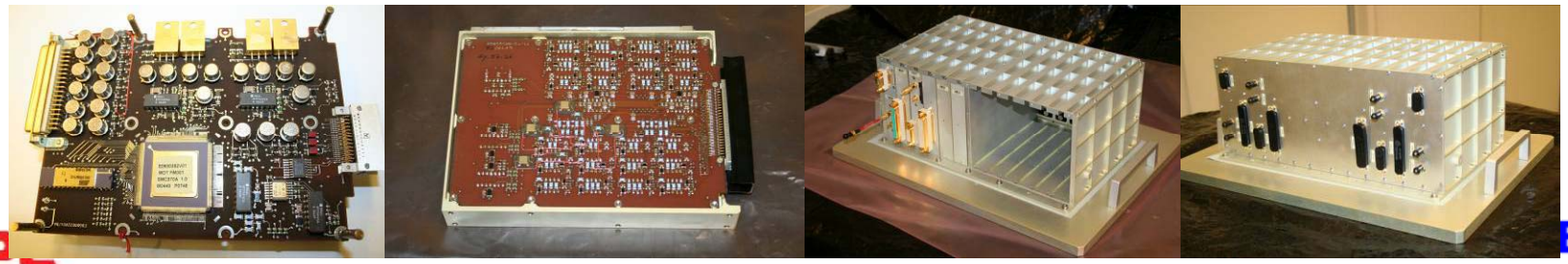
- **Have agreed requirements with GSFC**
- **Modified STM accordingly**
  - Envelope
  - Cube locations
- **TIM last week discussed integration into ISIM details**
- **STM re-assembly making good progress**

JPL
Jet Propulsion Laboratory
California Institute of Technology

MIRI European Consortium

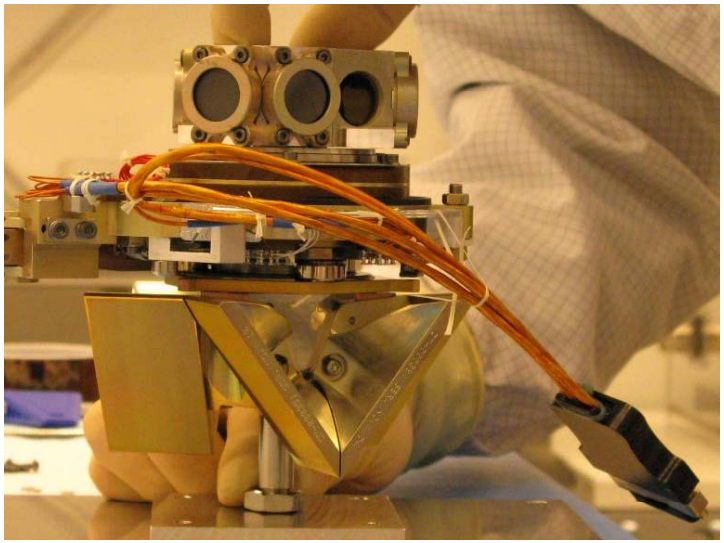
FM ICE Status

- **FM ICE has completed final assembly**
- **All testing completed & successful (vibration, thermal-vac, conducted emc, bakeout, outgassing)**
- **User Manual has been updated and new version issued**
  - Takes account of all comments
- **ICE now being prepared for delivery**
  - EIDP, report writing
  - preship review planned for June 9th



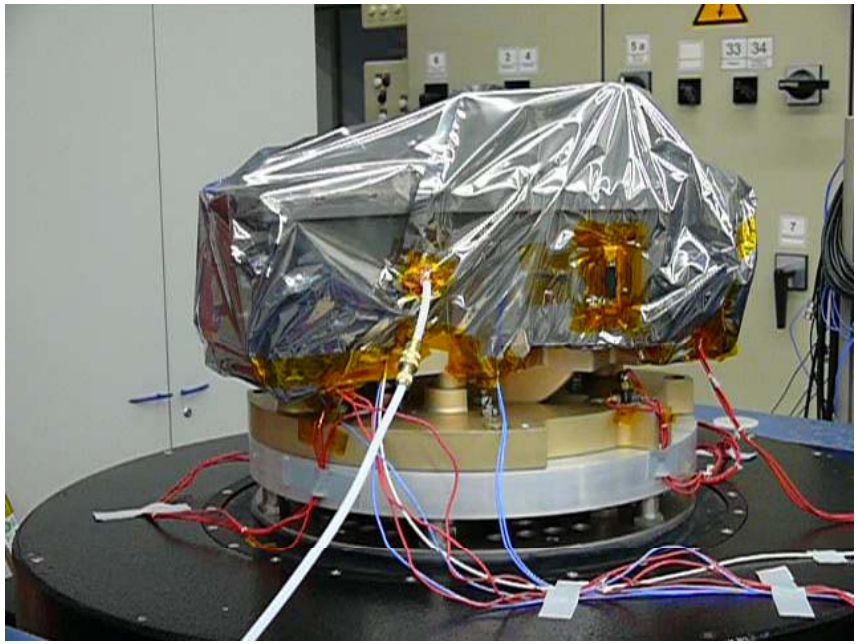
FM Dichroic Grating Wheel Assembly

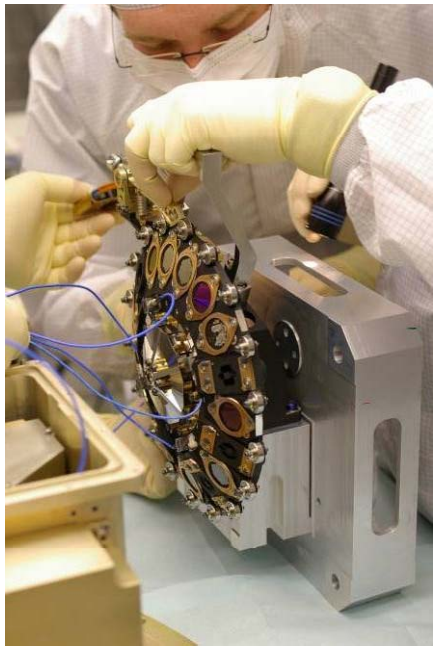
- **Gratings set 4, delivered to Astron in Jan 09, now integrated onto wheel.**
  - Did not need to implement plan to retro-fit them after mechanism testing
- **Precision mounting of index bearings achieves alignment requirements.**
- **Warm functional tests are OK so far**
- **Testing on-going**



FM Filter Wheel Assembly Testing

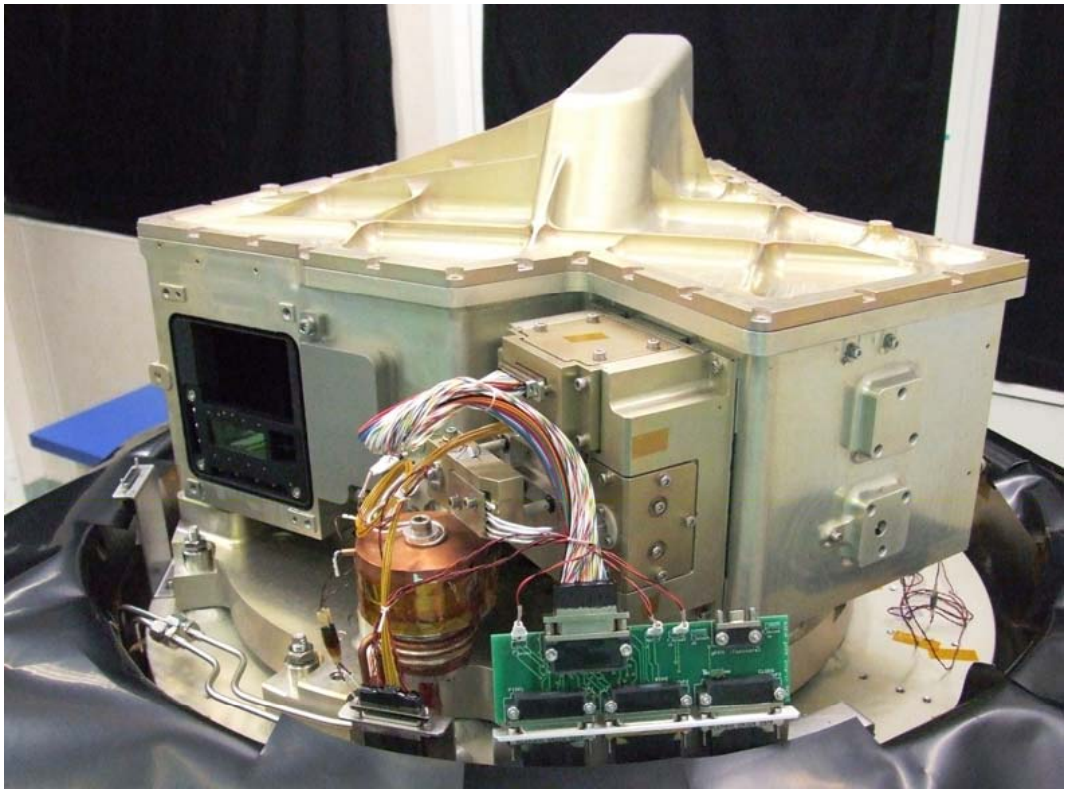
- **Functional and performance test successful completed**
  - Repeat accuracy better than 3 arcsec (absolute value) well within spec
- **Position sensor within budgeted ranges**
- **Hardware prepared for vibration test**
  - In progress this week .....





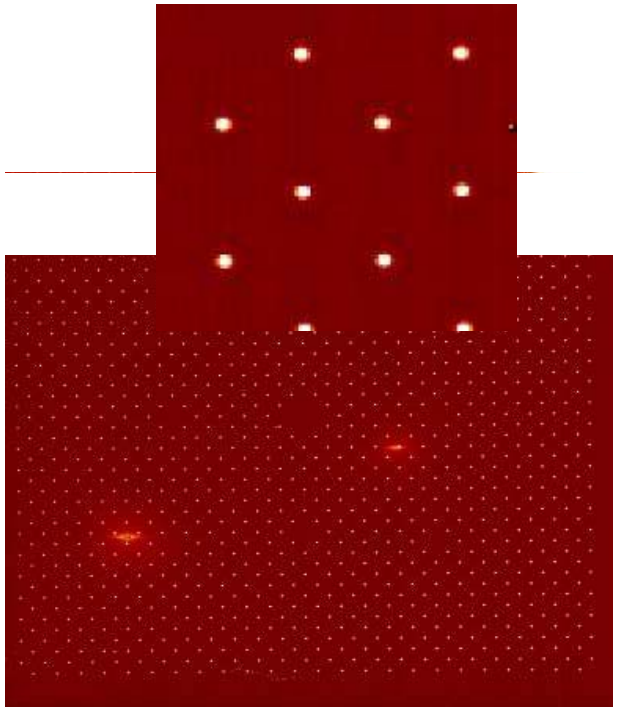
FM MIRI Imager Status

- **Integration complete**
- **Successful warm test**
- **Cryotest 1 and 2 complete**
  - Image Quality using a distortion grid.
  - Image performance test with the simulated point source.
  - Filter wheel is replaced by a single fixed filter for these tests

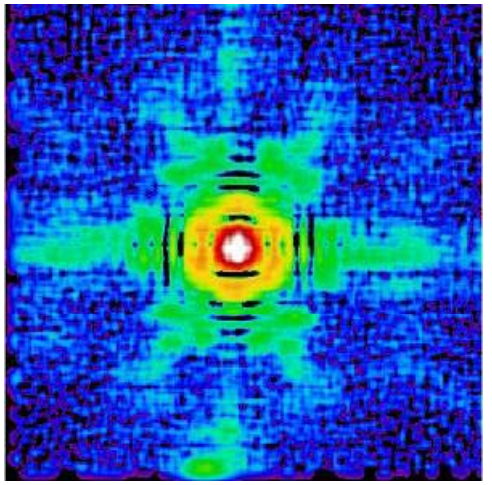


FM MIRIM Cryotest 1 and 2 Results

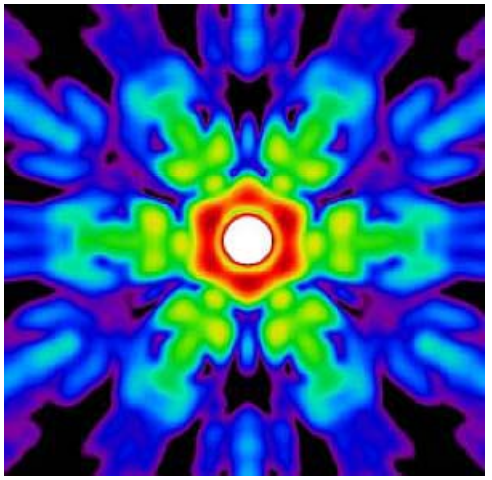
- **First indications are optical performances are all within specification**
  - Data analysis in progress



Distortion Grid at 7.2um



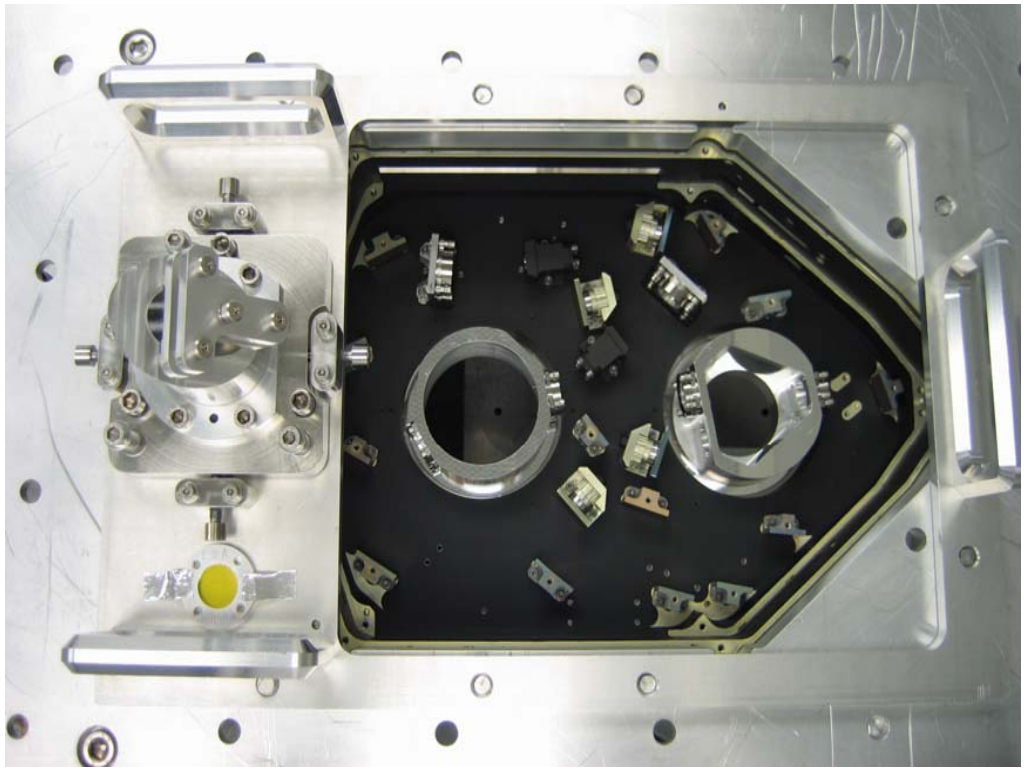
Point source at 5.6um



Simulation

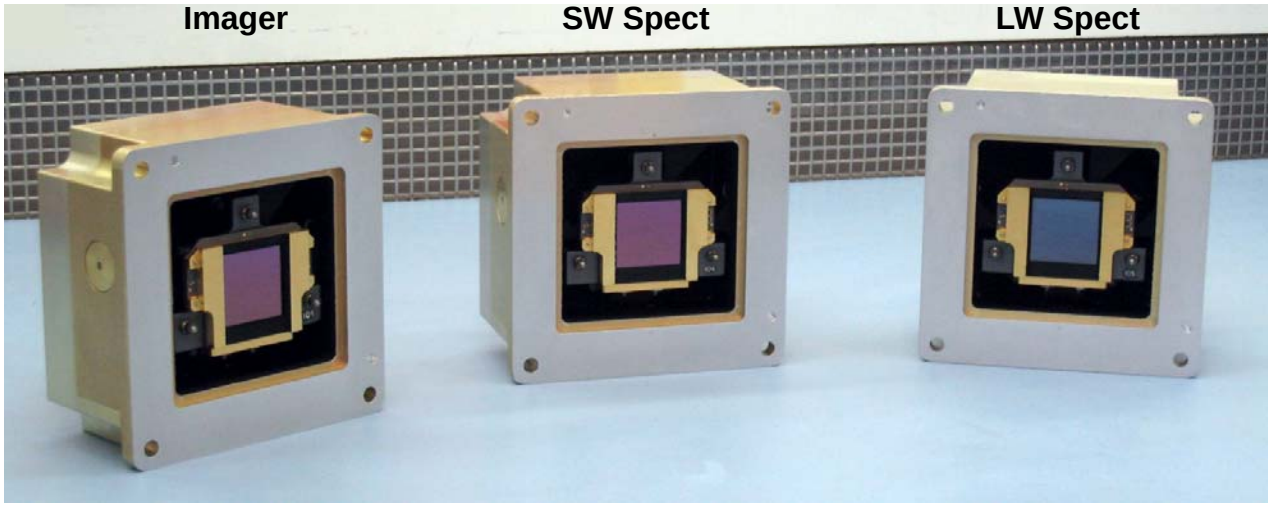
FM Spectrometer Pre-Optics Status

- **Fully Assembled**
- **Warm alignment and wavefront measurements completed**
- **Currently undergoing cryotest**



Channel 4, - 12 pupil images within IFU aligned with pupil aperture mask

Focal Plane System Status – Detectors & Modules

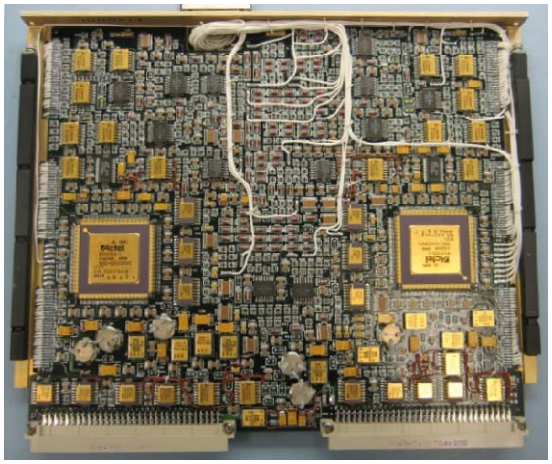


- **The 3 flight FPMs are complete and ready for higher level integration**
  - Detectors have very good performance and cosmetics
  - All alignment requirements are met
- **The LW spare is also complete; the SW spare is assembled and aligned – now in environmental test**
- **FPM task expected to be fully complete in August**
- **The Raytheon contract is essentially finished**
  - All hardware deliveries have been made
  - Residual parts have been dispositioned
  - Expect formal closure by the end of May

Focal Plane System Status – Electronics & Software

- **The flight boards are assembled tested**
  - SpaceWire communications (2)
  - Thermal control (3) (not present in this picture)
  - Signal chain (3) (digital and analog)
  - Power distribution unit (2)
- **Flight-like testbed electronics have been run with a flight-like FPM**
  - Functionality verified
  - Confirmed fixes for EM issues
    - Excess detector heat dissipation for subarrays
    - Duplication of left side reference pixels
    - First/last frame effect (significantly reduced)
  - Currently debugging two analog signal chain issues
- **Preparations for FM FPE box-level testing and subsequent FM FPS testing are underway**
- **Flight software is progressing**
  - FPS command and telemetry software is mature
  - ICE and Cooler modules are under development

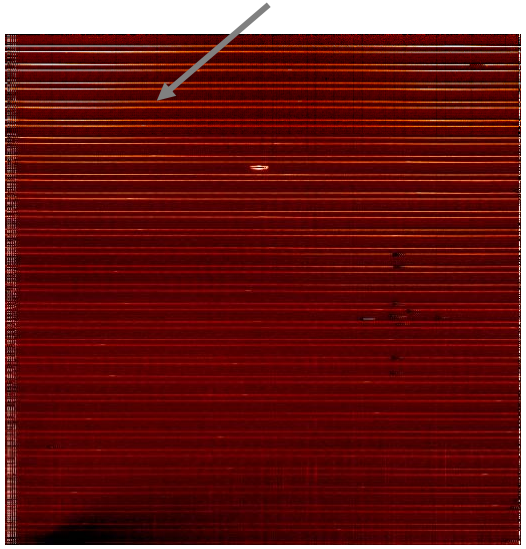
FM Chassis



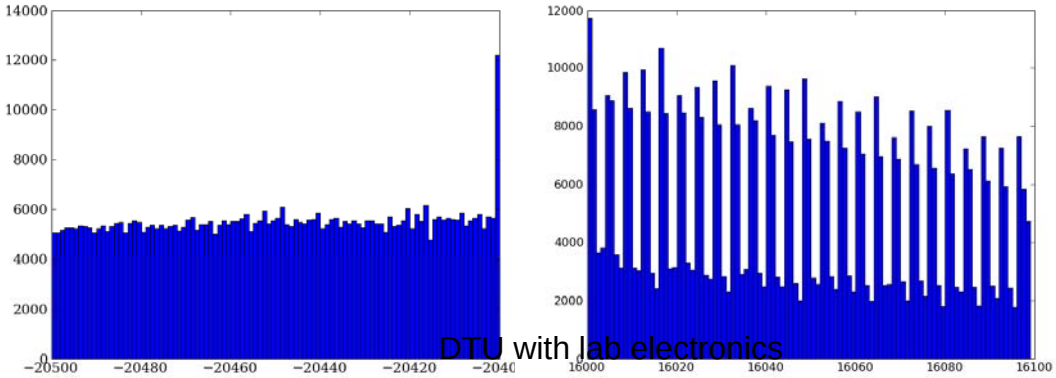
Det Clock & Bias Generator

Two Issues in Signal Chain Electronics

Stripes caused by pickup from heater drive circuit



Errors in digital values caused by high currents internal to A/D converters

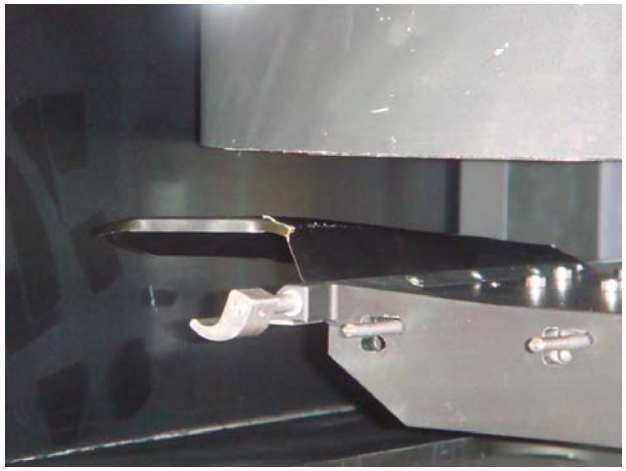


DTU with lab electronics

- **Both problems discovered while testing a flight-like electronics testbed with our Detector Test Unit (DTU), a flight representative FPM**
- **Extensive test programme now underway to find and test solutions**
- **ADC bit errors are due to inadequate ground planes and power supply bypassing, given the high currents during the conversions**
  - Investigating use of daughter boards to fix on all 5 detector readout channels
  - Patch implemented for 1 channel has been shown to work in tests yesterday
- **Thermal control pickup is caused by the switching drive circuit and is not synchronous with the detector data**
  - Investigations just beginning

MIRI Telescope Simulator Status

- **Vignetting - Problems with LSS and PSS**
  - Manufactured replacement parts
  - Control software modified
  - Repairs made and now in test
- **Image quality/focus problems traced to multiple causes**
  - MTS built to wrong focal length
    - Ie not to spec
  - Flat/fold mirror mounts partial cause of astigmatism
    - Cryotest underway to confirm
  - MOS secondary possible misalignment/displacement
    - Investigation on-going
- **MTS rebuild is not on critical path for FM testing**



Preparations for FM Testing

- **Perfe**
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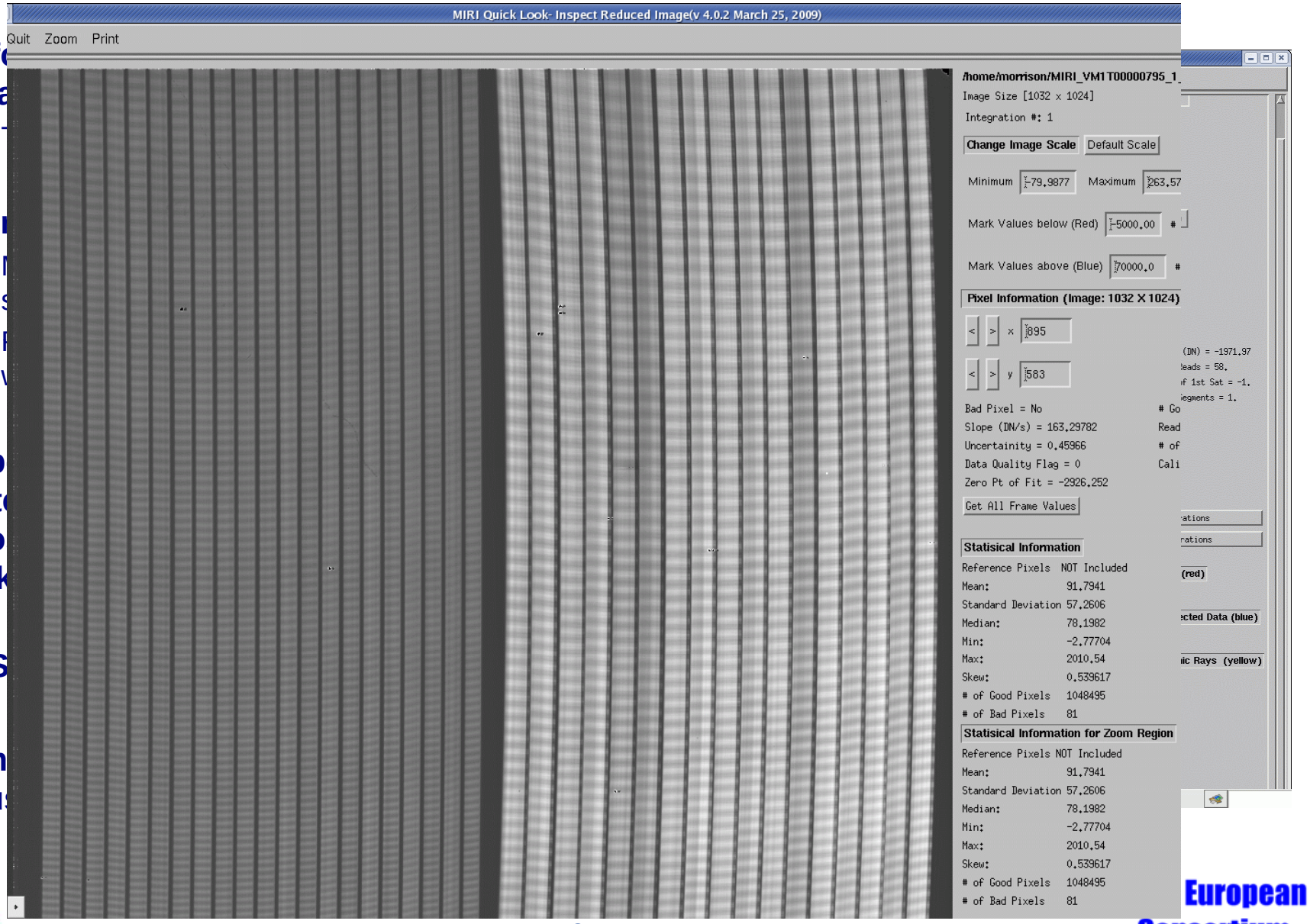
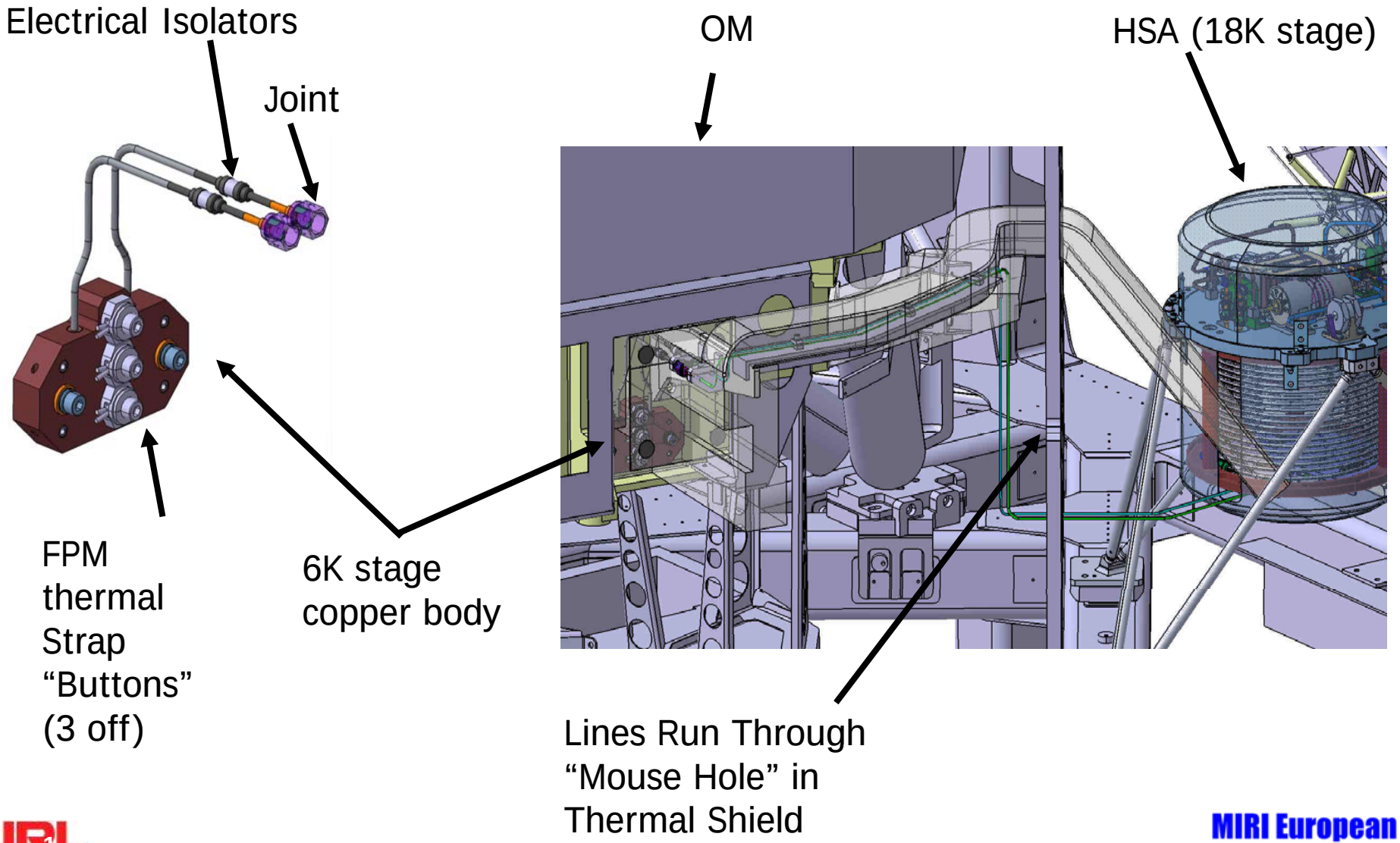
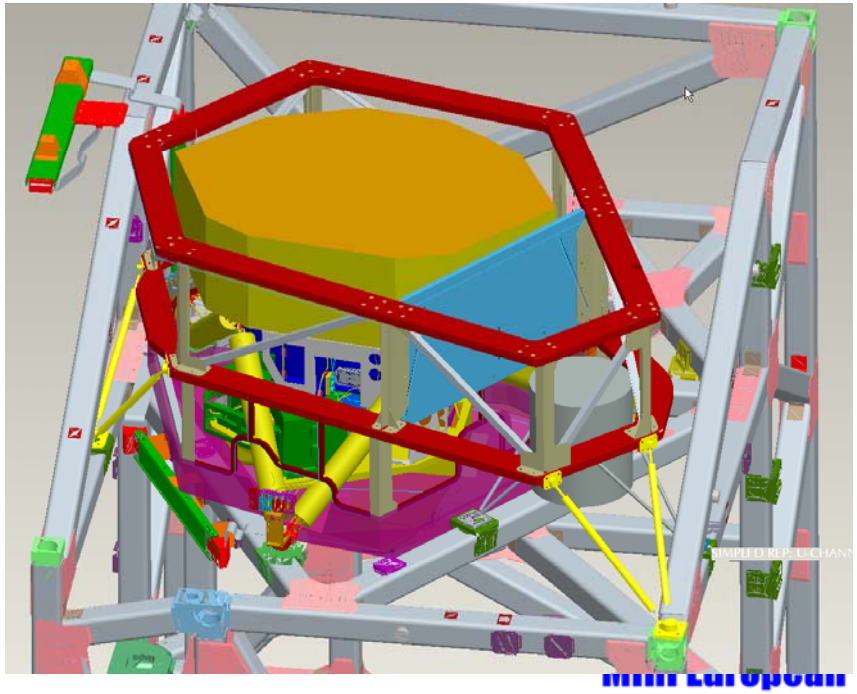


6K cold head interface to OM developed with JPL and Goddard



MIRI Shield

- **Review of VM thermal balance test results and analysis**
- **Review of total of all heat loads onto cooler 6K identified need to have additional margins at system level on load to cooler**
  - Uncertainties and late testing of integrated system
  - Low margin predicted for parasitic loads on coolant lines
  - Sensitivity of MIRI OM load to ISIM temperature environment
- **ISIM will provide active MIRI shield (connected to Cooler 18K stage) to provide significant additional margin, baselined December 2008**
- **Shield Concept review (PDR level) passed successfully on May 12th 2009, CDR Jan 2010**
- **The system yields a savings of ~30mW at the 6K stage in exchange for an increase of ~55mW at the 18K stage**
  - The increase in 18K heat load appears easily offset by the additional heat lift afforded by the reduction in 6K heat lift

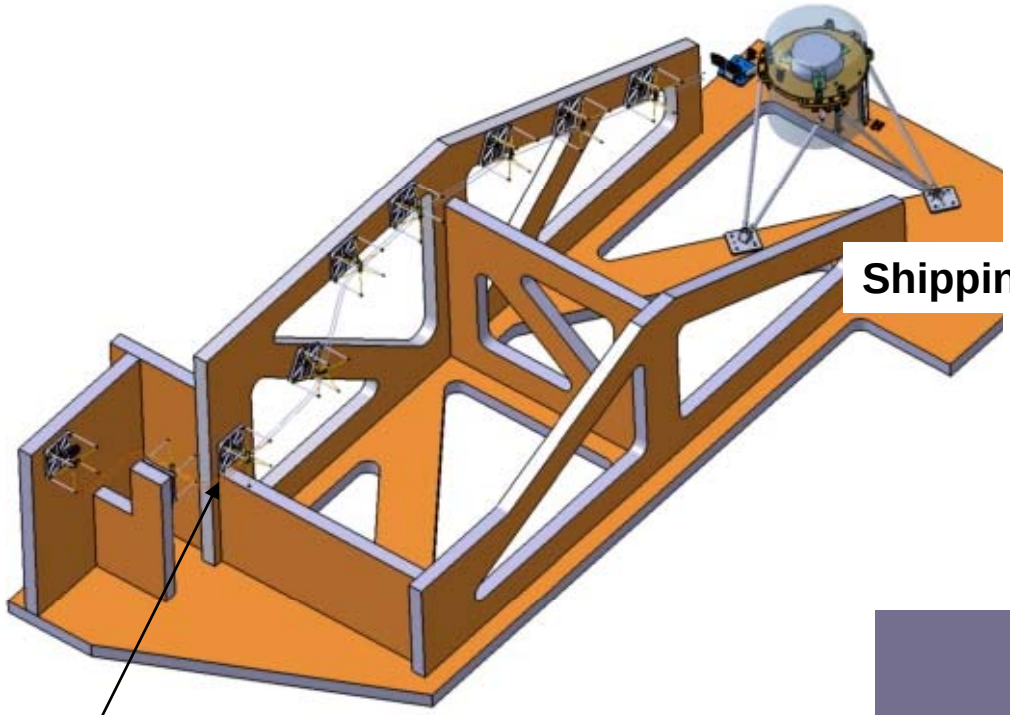


MIRI Cooler System Highlights

- **System margin issue of Cooler lift capability and loads solution in work**
  - JWST requirement for CDR to have >50% margin between CBE loads and lift capability
  - ISIM implementing an shield cooled actively by the MIRI Cooler 18K stage to reduce the 6K loads
    - Preliminary analysis shows > 55% margin between updated CBE loads (6K and 18K MIRI Shield plus line loads CBEs) and Cooler lift capability
- **Interfaces maturing towards Cooler CDR**
  - MICDs with ISIM and OTE/SC are in final revision and release cycle
    - Interfaces have been stable since March allowing Cooler CDR work to move forward
  - MIRI-OM to Cooler MICD update was delayed while MIRI Shield design concept matured
    - Have agreed path forward now that MIRI Shield has completed its Concept Review
- **Cooler design progressing towards Cooler CDR late June, 2009**
  - Detailed final design work using interface definitions as defined by early March
    - Some open interfaces do remain: 6K line routing, Tower region hardware
    - Detailing beyond the current baseline design being delayed on both these areas until the interface definitions are complete
  - Electronics boards and RSA progressing through their Internal Design Reviews in preparation for CDR
  - Cold Head Assembly fit check unit components are in fabrication
  - Cooler 18K stand legs design ready for final peer review and Manufacturing Readiness review
    - Dynamics of stand and HSA undergoing final analysis do to late update (early April) of ISIM launch environment
- **JPL preparing to hold a pre-CDR Verification and Validation Review covering the full Cooler V&V, pre and post delivery (June 2)**

Cold Head Assembly (CHA)

HSA

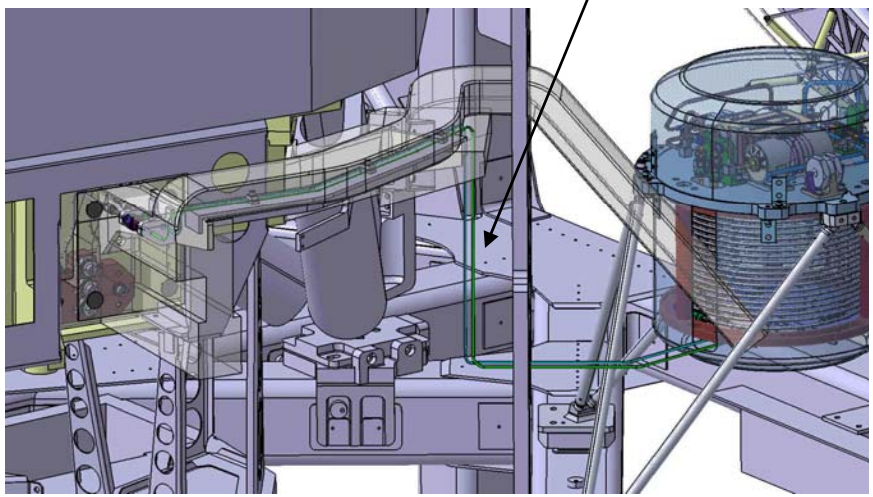


Shipping and assembly fixture

18K Line routing

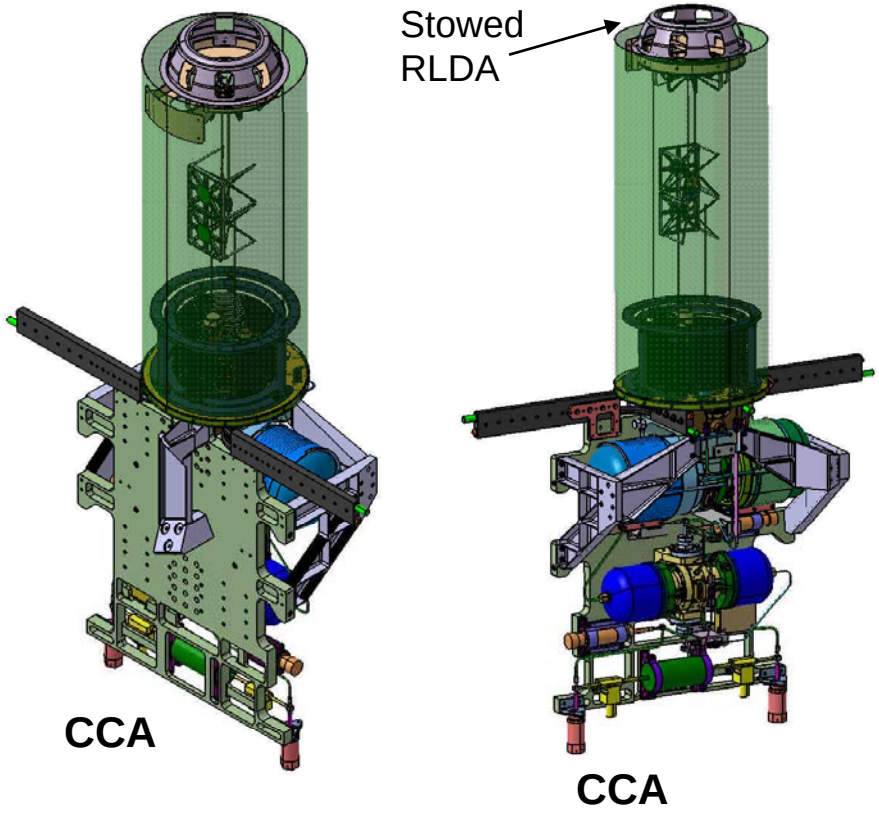
6K Line routing

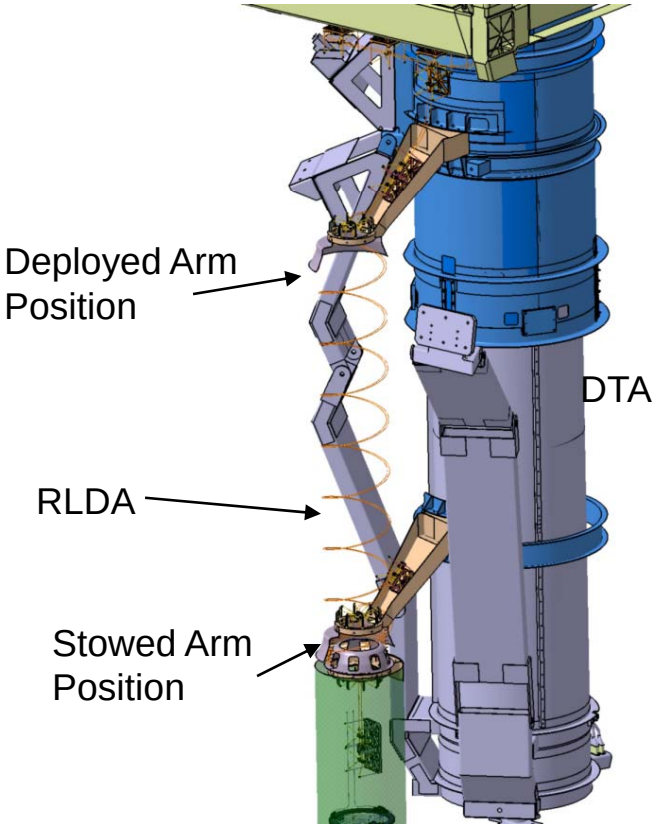
HSA



CTA and CCA

- **Updated CCA design for CDR complete including recent changes to 10Hz isolator support brackets**
- **Working closely with the Observatory to understand Cooler exported jitter up the CTA**
  - New requirements are being drafted

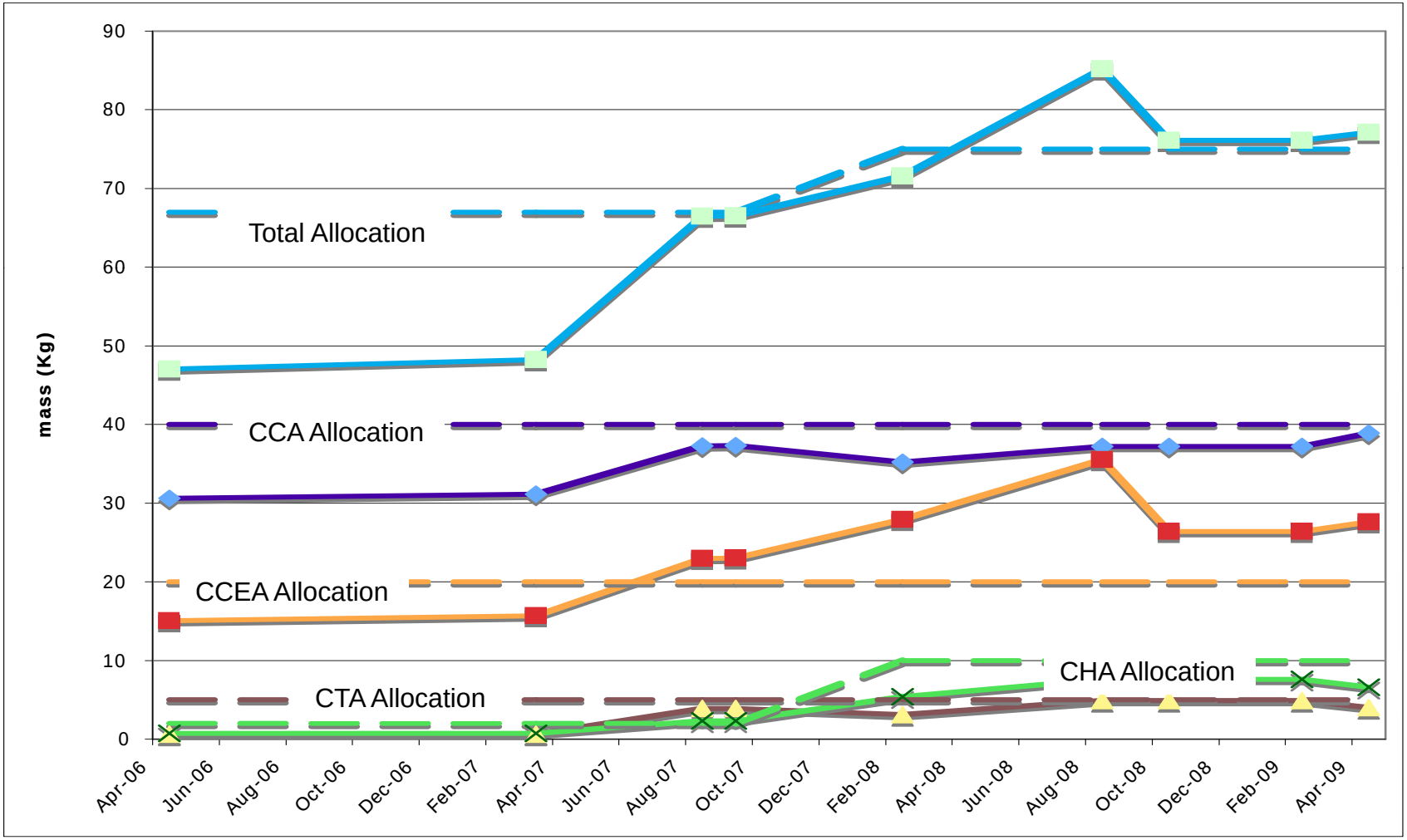




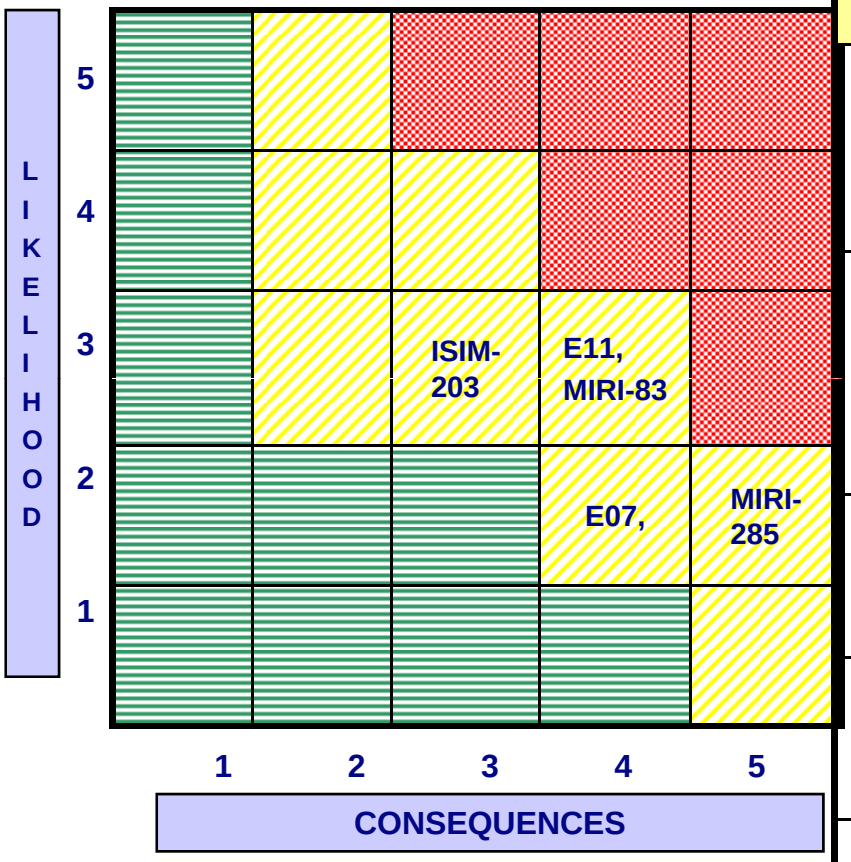
Region 3 “Chimney”
(Shown for reference)

Resources: Mass

Note: Increase to CCEA allocation in work (RTC) from 20kg to 27.9Kg.
With that change, Cooler mass comfortably below allocation in all areas



MIRI Top Risk List & Risk Matrix



Criticality	Approach
High	M - Mitigate
Med	W - Watch
Low	A - Accept
	R –Research

Rank	Risk ID	L	C	Mitigation Approach	Risk Title
1	MIRI-83	3	4	R ISIM MIRI Shield adds Margin	Unexpected thermal loads on cooler
2	E11	3	4	W	Late delivery of Wheel Mechanism Assemblies or FPS delays instrument integration
3	MIRI-285	2	5	A Spitzer heritage and lessons	SCA Single Point Failure
4	ISIM-203	3	3	M Add reflective PAR, VM Test	MIRI Pupil Alignment
5	E07	2	4	A ISO heritage, extended FM test before integration	Parallel Wheel Mechanism Qualification Program

Conclusions

- **We are making steady progress with both the Optical System and the Cooler System**

- **Half of the sub-assemblies needed for OS construction have completed testing and are delivered or ready for delivery**

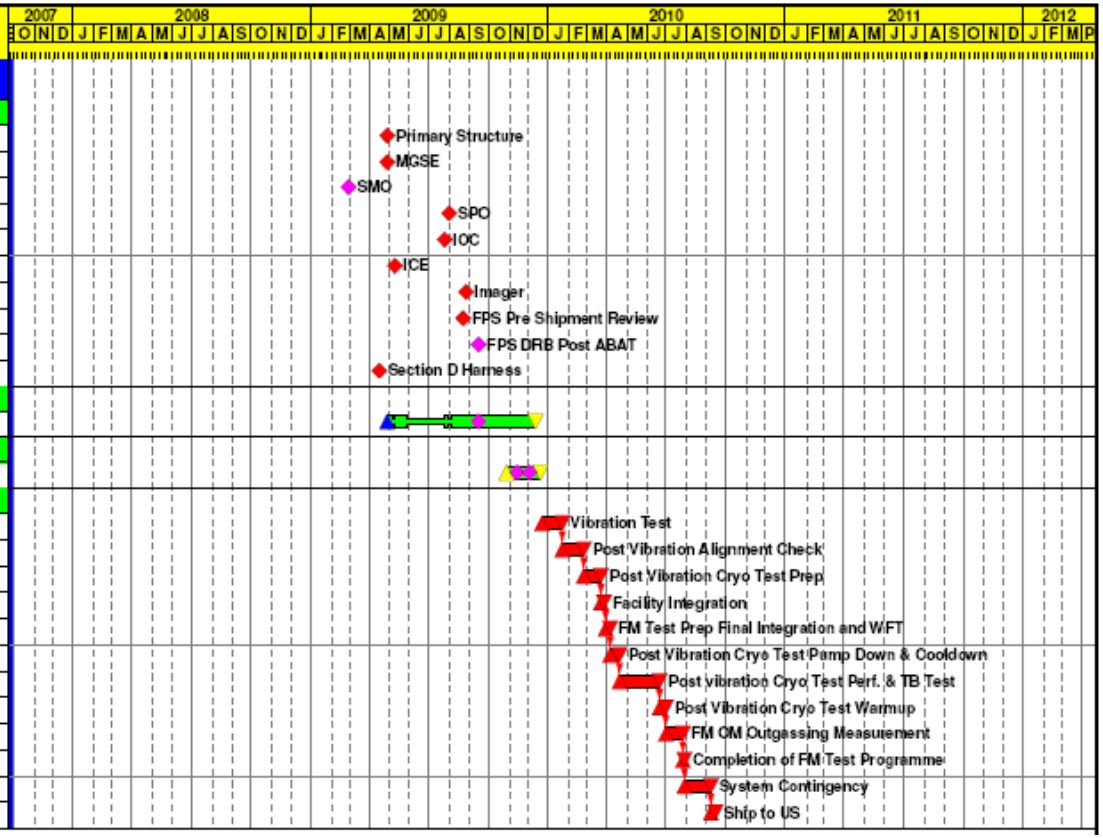
- **Next Steps OS**
  - FPS System tests at JPL
  - Complete testing of IOC and SPO
  - Complete environmental testing of wheel mechanisms
  - Refurbish MTS and test
  - Instrument Assembly late 2009
  - FM cryotest campaign spring 2010 (April)

- **Next Steps CS**
  - Cooler CDR
  - Complete manufacture and assembly of Cooler Cold Head Assembly (CHA) fit check unit
  - Finalize design of Cooler Tower Assembly detailed design
  - Finalize MICD with OM now that shield design complete

Back-up Slides

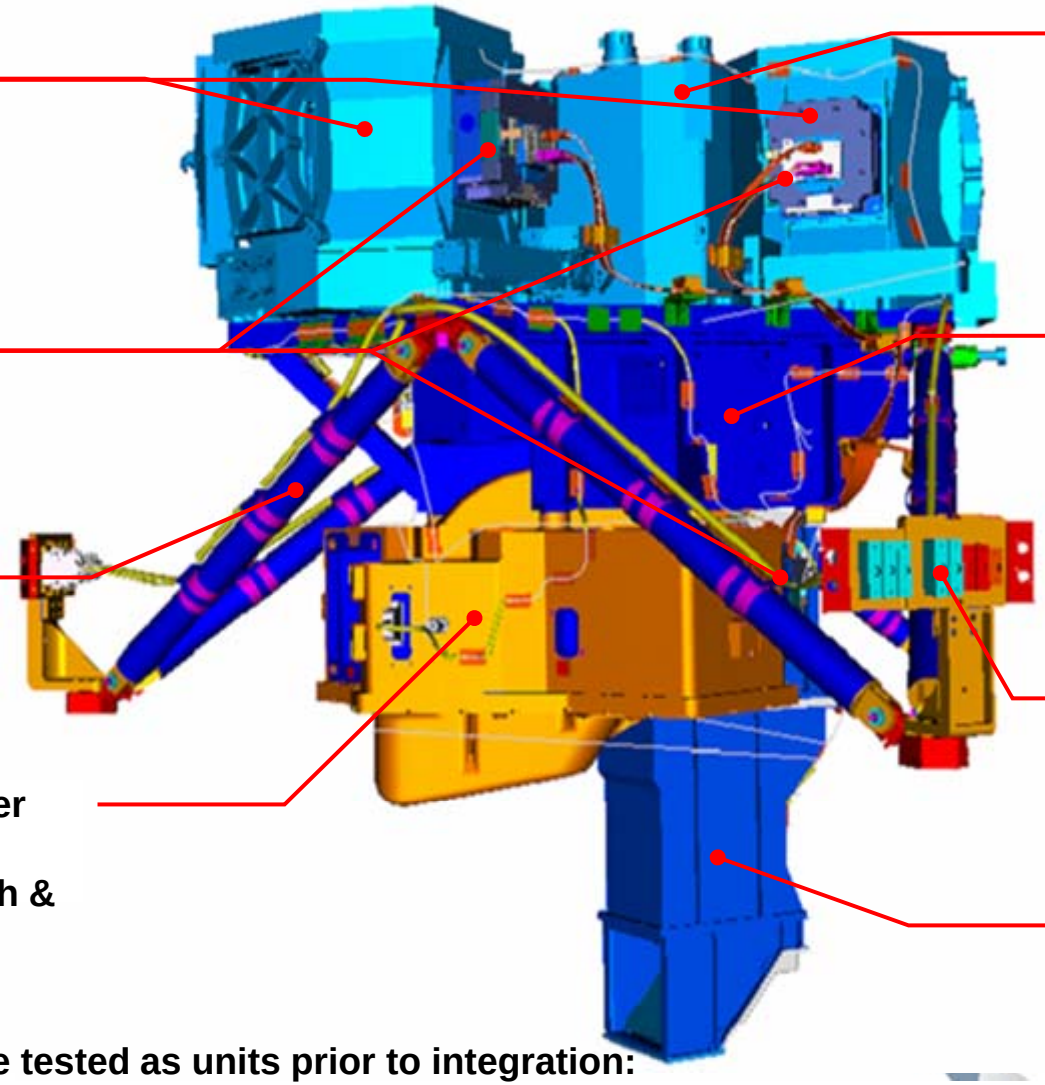
FM Schedule Status Summary

Activity Description	Early Start	Early Finish
MIRI FM Schedule		
FM Deliveries		
Primary Structure		28APR09*
MGSE		28APR09*
SMO		26FEB09A
SPO		31JUL09*
IOC		23JUL09*
ICE		08MAY09*
Imager		27AUG09*
FPS Pre Shipment Review		21AUG09*
FPS DRB Post ABAT		15SEP09
Section D Harness		15APR09*
+ FM Instrument Integration		
		11DEC09
+ FM Test Setup		
	29OCT09	18DEC09
FM Testing		
Vibration Test	21DEC09	20JAN10
Post Vibration Alignment Check	21JAN10	23FEB10
Post Vibration Cryo Test Prep	24FEB10	22MAR10
Facility Integration	23MAR10	26MAR10
FM Test Prep Final Integration and WFT	29MAR10	05APR10
Post Vibration Cryo Test Pump Down & Cooldown	06APR10	20APR10
Post vibration Cryo Test Perf. & TB Test	21APR10	19JUN10
Post Vibration Cryo Test Warmup	20JUN10	30JUN10
FM OM Outgassing Measurement	01JUL10	26JUL10
Completion of FM Test Programme	27JUL10	27JUL10
System Contingency	26JUL10	07SEP10
Ship to US	08SEP10	14SEP10



Dates shown do not account for recently discovered FPE signal chain issue. FM delivery date will be reviewed when FPS and wheel mechanism test schedules stabilise

MIRI Optical Configuration



Spectrometer Main Optics (SMO)

Focal Plane Modules (FPM)

CFRP Hexapod

MIRI Imager (incl. Coronagraph & LRS)

Spectrometer Pre Optics (SPO)

Primary Structure Deck

Interface Connector Panels (ICP x 3)

Input Optics & Calibration (IOC)

Sub-assemblies are tested as units prior to integration:
SPO, SMO, Deck, Hexapod, IOC, MIRIM, harness, FPM/FPE

VM Cryo-Test Campaign – aims

- **VM 1 cryotest**
  - We do (or do not) basically have a working instrument and if not we have a good idea as to why not and ***how to fix the FM***
    - End-end functioning
    - Blanket performance
    - A point source looks like a point source
    - The cal source illuminates the spectrometer detectors
    - Imager and spectrometer are both in focus (or not)
    - The wheels go round, the CCC moves, the sensors can be read out
    - Throughput is what we expected to see.
    - We can get dark
    - Checkout data chain
    - Annelaing of detectors, detector modes, pom heater works

- **VM 2 cryotest**
  - The MTS is basically working (or not) and if not we know **what to fix for FM**
    - e,g. On/off/movement of source/brightness of source is OK or not
  - There is no unexpected straylight in either imager or spectrometer
  - “Dry run” team organisation, scripts etc

- ***Any other performance tests of the VM are a bonus***